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THE MOUNTAIN TOP TRACK.

A DESCRIPTION

OF THE

RAILROAD ACROSS THE BLUE RIDGE

AT

ROCK FISH GAP,

IN

THE STATE OF VIRGINIA.

Maximum Grade, 296 feet per mile.
Least Radius of Curvature, 234 feet.

By CHARLES ELLET, Jr.,
CIVIL ENGINEER.

PHILADELPHIA:
T. K. & P. G. COLLINS, PRINTERS
1856.

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NOTE.

SHOULD any reader think this account of the Mountain Top Track superfluous, it may be a sufficient excuse for its publication to inform him that until the success of the work had entirely justified its construction, its practicability was very generally doubted by the public.

It may be an additional justification to add, that the difficulties overcome in the location and working of the line, very much exceed those which have made the Austrian road over the Semmering famous throughout Europe, while they have confirmed the claim of the American locomotive, in climbing steep grades, to unrivalled pre-eminence.

No. 288 H Street, Washington, D. C.,
December 1, 1856.

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THE MOUNTAIN TOP TRACK.

The Mountain Top Track, which passes over the Blue Mountain in Virginia, is probably, in many particulars, the most remarkable railroad now in use; and, demonstrating as it does fully and practically the capability of the locomotive engine to traverse lofty mountains, and to introduce the benefits of the railroad system into regions which have been hitherto very generally considered inaccessible, the writer deems this road, constructed under his direction in opposition to considerable professional and official resistance, now that its performance has vindicated the soundness of his opinion, deserving of a brief description.

It was considered throughout the world a great triumph when France, under the First Consul, had opened a road across the Alps, along which the artillery of Napoleon might be dragged by horses into Italy.

The Mountain Top Track, which is scarcely known out of the State of Virginia, proves, by its daily achievements, that the Alps themselves may now be surmounted without tunnelling by the modern locomotive with its train.

In fact, the engines daily running on this road, and drawing after them regular trains of forty or fifty tons of freight and passengers up grades rising at the rate of 296 feet per mile, and swinging their trains of eight wheel cars around curves of less than 300 feet radii, are capable of carrying the artillery and supplies of an army up the steepest slopes of the present road over the Simplon, and offering facilities to an invader that would have been deemed impossible a very short time ago.

A brief account of this road is presented for the purpose of directing attention to one or two points which the writer conceives to be of much practical importance, and still greatly neglected in railroad construction.

We should not regard mountainous regions as necessarily excluded from participation in all the comforts and conveniences due to the railroad, because they can only be reached by lines of very steep grade or very abrupt curvature. The American locomotive can penetrate into the most retired valleys of Switzerland, and bring forth the products of their industry. Wherever men can go to cultivate the earth with profit, there the locomotive can follow to take away the produce of their toil.

Companies are frequently deterred from prosecuting works which present serious physical obstacles, because they are unable to provide the means to overcome the difficulties in the precise mode set down in their plans. But, by departing temporarily, at difficult points, from their ultimate designs, they can almost always evade these impediments at small cost, whether they consist of lofty mountains which must finally be tunnelled, or of deep

ravines which must be bridged over or filled up. Steep grades and curves of short radii will serve to carry the track over the opposing difficulties, and often enable the road to produce a revenue which will permit the ultimate and sometimes the speedy perfection of the plan.

There are now, and always, many railroads languishing for want of means to complete certain isolated heavy works, which might be easily evaded for a temporary purpose by high grades and short curves, that would delay the trains but a few minutes, and add a mere trifle to the aggregate cost of transportation, and yet permit the Company to prolong its line, and work it advantageously until prepared with means to execute, and trade sufficient to justify, the cost of the permanent arrangement proposed.

It will often be found that the mere interest on the cost of the permanent work that may be temporarily evaded, will alone be sufficient to pay for the construction of the temporary substitute; and often, too, that the substitute would serve to develop a business of which the growth would have been much retarded had the completion of the permanent work been waited for.

Cases frequently occur, also, where the facilities offered for the construction of the heavy work, by permitting the locomotive to go forward on a temporary track, would greatly reduce the aggregate cost and accelerate the completion of the enterprise.

These general views were fully and practically sustained by Mr. Latrobe, the able and distinguished engineer of the Baltimore and Ohio Railroad, when he passed his engines and trains over the mountains in anticipation of

the completion of the Kingwood and Board Tree Tunnels. He did not permit hills or hollows to stand between his locomotives and the Ohio River; but surmounted the difficulties and carried his work forward, and accommodated the public wants, and satisfied the impatience of his company by a temporary but an adequate expedient.

The writer, in face of energetic professional opposition, has successfully applied the same system in Virginia, and thinks its application may be judiciously extended to many other works where hopes long deferred may be speedily realized. He does not wish, however, to be understood to advocate such roads for temporary use only. On the contrary, he is convinced that there are many points where roads of very high grades—grades of 200, or, in extreme cases, more than 300 feet per mile—may be justifiably introduced for permanent use.

OBJECT OF THE MOUNTAIN TOP TRACK.

This track across the Blue Ridge was constructed by the Virginia Central Railroad Company for a temporary purpose. It forms a part of the great line in course of construction through Central Virginia, from Richmond to the Ohio, at the mouth of the Big Sandy River.

The length of the entire route will be 430 miles; of which the Central Railroad Company controls 206 miles, extending from tidewater at Richmond to the town of Covington on Jackson's River, and near the eastern base of the Alleghany Mountains.

Of the 206 miles controlled by the Central Company,

the State of Virginia, for reasons to which it is unnecessary here to allude, undertook the construction of the 17 miles embracing the passage of the Blue Ridge, and the tunnel which it had been decided should be formed through that mountain.

For other reasons, which it is also unnecessary here to state, the progress of the tunnel and the other work which the Commonwealth had assumed, was not as rapid as had been expected, and as the interests of the Central Company demanded. That Company had completed its own road from Richmond, 107 miles, up to the assumed base of the Blue Ridge, where the State's road commenced, and were also preparing for the rapid extension of their line westwardly beyond the mountain, leaving the gap which was under the control of the Commonwealth to be overcome by stages and teams.

Such was the condition of things when, in April, 1853, the writer was appointed Chief Engineer of the Central Railroad Company. An examination of the condition of the work which had been put under his professional charge, and that of the State, which was essential both to the continuity and success of the other, satisfied his judgment that the prosperity of the entire interest involved required that the Blue Mountain should be crossed by the cars immediately, with a tunnel or without a tunnel.

The work on the tunnel, including the preparatory surveys, had then been in progress over four years, and it was very obvious that nearly or quite three years more would be required, supposing the same rate of progress to be continued, for its completion. He so reported

to the Directory at their first meeting after his appointment, and advised them to authorize him to construct a temporary railroad across the mountain, to be worked by locomotive power, and to commence that undertaking forthwith.

The suggestion was approved. A force was collected as expeditiously as possible, and the surveys were made and the general plans prepared before the contractors reached the ground with their men.

The construction was commenced at a period when there was a most unusual demand for labor, and it was extremely difficult to procure an adequate supply.

The mountain itself could furnish but little of anything needed. Large quantities of lumber were required to form tressels by which to bridge the six deep ravines indented in the slope of the mountain. But timber was scarce and difficult to procure. The material to be excavated was stubborn, the greater portion being composed of rock. The time required to complete the road and bring it into use was consequently prolonged.

From the first breaking ground until the engines crossed the summit was seven months.

DESCRIPTION OF THE ROAD.

The Mountain Top Track crosses the summit of the Blue Ridge at Rock Fish Gap, where the elevation of the mountain is 1,885 feet above tide. The crest of the ridge is very narrow, and is passed on a curve of 300 feet radius.

There is barely room for an engine with an ordinary train to stand on the summit, before the road slopes off, descending both towards the east and west, to the valleys on either side of the ridge.

WESTERN SIDE.—The length of the descent on the western side, from the summit to what is here assumed to be the foot of the mountain, is 10,650 feet, or $2\frac{2}{100}$ miles.

The track descends in this distance, on the west side, 450 feet—or, at the average rate of one foot in $23\frac{2}{3}$ feet.

The *average grade* on the western slope is, therefore, $223\frac{1}{10}$ feet per mile.

The *maximum grade* on the western slope is $5\frac{3}{10}$ feet in 100, or $279\frac{84}{100}$ feet per mile.

On both sides of the mountain the ruling curves are described with a radius of 300 feet, on which the grade is $237\frac{6}{10}$ feet per mile.

The excess of the maximum over the average grade is occasioned by the attempt to compensate, in the distribution of the necessary ascent, for the effect of curvature. There was no experience to guide the writer in the arithmetical determination of the influence of such curvature as it was necessary to introduce upon this road, and the proper diminution of the slope required on the curves to compensate for the increased traction which would there be due to the curves. On this point professional information is still very deficient, even for curves of ordinary radii, traversed by engines of common construction propelled at the usual velocities of freight or passenger trains.

For such an anomalous line as the writer was about to construct, there was absolutely no guide; and his allowance was therefore almost entirely conjectural.

When the road was first opened, it speedily appeared that the difference of 43 feet on the western side, and 58 feet on the eastern side, between the grades on curves of 300 feet radii and those on straight lines, was not sufficient to compensate for the increased traction due to such curvature. The velocity, with a constant supply of steam, was promptly retarded on passing from a straight line to a curve, and promptly accelerated again on passing from the curve to the straight line.

But, after a little experience in the working of the road, it was found advisable to supply a small amount of grease to the flange of the engine by means of a sponge, saturated with oil, which, when needed, is kept in contact with the wheel by a spring. Since the use of the oil was introduced the difficulty of turning the curves has been so far diminished that it is no longer possible to determine whether grades of $237\frac{6}{10}$ feet per mile on curves of 300 feet radius, or grades of 296 feet per mile on straight lines, are traversed most rapidly by the engine.

Eastern Side.—But the more difficult portion of the work was on the eastern side of the mountain, where the ascent was greater, and the slope, in order to reach a certain level, which became a necessary condition of the problem of location, was required to be greater.

The length of the line of descent from the summit to the foot of the grade, is 12,500 feet, or $2\frac{3\,7}{10\,0}$ miles.

The road descends in this distance 610 feet, or at the average rate of one foot in $20\frac{1}{2}$ feet.

The *average grade* on the eastern slope is, therefore, $257\frac{4}{10}$ feet per mile.

The *maximum grade* on the eastern slope is $5\frac{6}{10}$ feet in 100, or $295\frac{68}{100}$ feet per mile.

This maximum grade is found in a continuous line of half a mile in length.

The shortest radius of curvature on this side of the mountain was intended to be 300 feet; but in the construction of the work a more abrupt curve was introduced at one difficult point, in order to throw the track further into the hill and keep the embankment off a face of sloping and treacherous rock. At this ravine, which is found about half way down the mountain, the radius of curvature is only 234 feet, and the grade upon that curve is $237\frac{6}{10}$ feet per mile.

The total length of the track from the foot of the mountain on the west side, across the summit, to the foot of the mountain on the east side, is $4\frac{39}{100}$ miles. But, in consequence of delays which occurred in the construction of other parts of the Commonwealth's road, it became necessary to extend the track $3\frac{1}{2}$ miles further, running it around unfinished cuts and embankments at four different points, so that the distance actually worked by the mountain engines is about *eight miles.*

THE LOCOMOTIVE ENGINES USED.

This road was opened to the public in the spring of 1854, and it has now, in the autumn of 1856, been in constant use for a period of more than 2½ years. In all that time the admirable engines relied on to perform the extraordinary duties imposed upon them in the passage of this summit, have failed *but once* to make their regular trips. The mountain has been covered with deep snows for weeks in succession, and the cuts have been frequently filled for long periods many feet in depth with drifted snow: the ground has been covered with sleet and ice, and every impediment due to bad weather and inclement seasons has been encountered and successfully surmounted in working the track.

During the last severe winter, when the travel upon all the railways of Virginia and the northern and western States was interrupted, and, on many lines, for days in succession, the engines upon this mountain track, with the exception of the single day already specified, moved regularly forward and did their appointed work. In fact, during the space of 2½ years that the road has been in use, they have only failed to take the mail through in this single instance, when the train was caught in a snow-drift near the summit of the mountain.

These results are due, in a great degree, certainly, to the admirable adaptation of the engines employed to the service to be performed; but they are due, also, in no

small degree to the skill and energy of the superintendent in immediate charge of the track and machinery.

The locomotives mainly relied on for this severe duty were designed and constructed by the firm of M. W. Baldwin and Company of Philadelphia. The slight modifications introduced at the instance of the writer to adapt them better to the particular service to be performed in crossing the Blue Ridge, did not touch the working proportions or principle of the engines, the merits of which are due to the patentee, M. W. Baldwin, Esq.

These engines are mounted on six wheels, all of which are drivers, and coupled, and 42 inches diameter. The wheels are set very close, so that the distance between the extreme points of contact of the wheels and the rail, of the front and rear drivers, is 9 feet 4 inches. This closeness of the wheels, of course, greatly reduces the difficulty of turning the short curves of the road.

The diameter of the cylinders is 16½ inches; and the length of the stroke 20 inches.

To increase the adhesion, and, at the same time avoid the resistance of a tender, the engine carries its tank upon the boiler, and the footboard is lengthened out and provided with suspended side boxes, where a supply of fuel may be stored. By this means the weight of wood and water, instead of abstracting from the effective power of the engine, contributes to its adhesion and consequent ability to climb the mountain.

The total weight of these engines is 55,000 pounds, or 27½ tons, when the boiler and tank are supplied with

water, and fuel enough for a trip of eight miles is on board.

The capacity of the tank is sufficient to hold 100 cubic feet of water, and it has storage room on top for 100 cubic feet of wood, in addition to what may be carried in the side boxes and on the footboard.

To enable the engines better to adapt themselves to the flexures of the road, the front and middle pair of drivers are held in position by wrought-iron beams, having cylindrical boxes in each end for the journal bearings, which beams vibrate on spherical pins fixed in the frame of the engine on each side and resting on the centres of the beams. The object of this arrangement is to form a truck, somewhat flexible, which enables the drivers more readily to traverse the curves of the road.

There were three engines constructed expressly for this track, of which two answer to the description here given. The third engine was built by Mr. Joseph R. Anderson, of Richmond, and is an excellent machine and capable of doing good service. Resting on eight wheels, and being more rigid than the others, it does not yield so easily to the very short curves of this track. It is therefore kept on hand as a reserve engine, and is frequently employed to relieve the regular engines of the road.

Duties and Speed of the Engines.—The writer has never permitted the power of the engines on this mountain road to be fully tested. The object has been to work the line regularly, economically, and, above all, *safely;*

and these conditions are incompatible with experimental loads subjecting the machinery to severe strains. The regular daily service of each of the engines is to make four trips, of eight miles, over the mountain, drawing one eight-wheel baggage car together with two eight-wheel passenger cars, in each direction.

In conveying freight, the regular train on the mountain is three of the eight-wheel house cars fully loaded, or four of them when empty or partly loaded.

These three cars, when full, weigh with their loads from 40 to 43 tons. Sometimes, though rarely, when the business has been unusually heavy, the loads have exceeded 50 tons.

With such trains the engines are stopped on the track, ascending or descending, and are started again, on the steepest grades, at the discretion of the engineer.

Water, for the supply of the engines, has been found difficult to obtain on the mountain; and since the road was constructed a tank has been established on the eastern slope, where the ascending engines stop daily on a grade of 280 feet per mile, and are there held by the brakes while the tank is being filled, and started again at the signal and without any difficulty.

The ordinary speed of the engines, when loaded, is 7½ miles an hour on the ascending grades, and from 5½ to 6 miles an hour on the descent.

Greater speed and larger loads might doubtless be permitted with success; but the policy has been to work the track with perfect safety, to risk nothing, and to obtain and hold the public confidence.

BRAKES, COUPLINGS, &c.

In recommending the use of this anomalous track for the conveyance of passengers, the writer felt severely the great responsibility of his position. No care that his judgment and foresight could provide was neglected to secure the most perfect safety to those whose lives were intrusted in the hands of the Company and its agents.

The rule was adopted that no car should be suffered to cross the mountain that did not possess a brake for every wheel, of power sufficient to clutch the wheel firmly and prevent its rotation. All fixtures by which the brakes might be acted upon by the engineer, and the power conveyed simultaneously to all the wheels through a common bar or chain, were rejected, because the giving way of this connecting bar would render all the brakes which were made dependent upon it powerless.

The brakes were required to be inspected carefully at every trip by an experienced man, and to be in perfect order for service before the mountain engine could be attached to the train.

The giving way of a coupling was another source of danger to be guarded against upon such grades; for, if the brakemen on the ascending train should be neglectful, and fail to apply their brakes when a coupling bar or bolt should break, the disengaged car might be carried down the grade.

To guard against this danger, reliable couplings were provided for all the cars; and, for further security against

the possibility of such an accident, two powerful tug chains were attached as extra couplings between the locomotive and the forward car, and also between each two separate cars, which are reserved couplings, coming into service only in case the regular coupling bar or its connections should part. These guard chains are always attached as soon as the mountain engines, or "climbers," as they are called, are put on.

When the track is in good condition, the brakes of only two of the cars possess sufficient power to control and regulate the movement of the train—that is to say, they will hold back the two cars and the engine. When there are three or more cars in the train, the brakes on the cars, of course, command the train so much the more easily.

But the safety of the train is not dependent on the brakes of the cars. There is also a valve or air cock in the steam chest, under the control of the engineer. This air cock forms an independent brake, exclusively at the command of the engineer, and which can always be applied when the engine itself is in working order. The action of this power may be made ever so gradual, either slightly relieving the duty of the brakes on the cars, or bringing into play the entire power of the engine.

The train is thus held in complete command. Yet no precaution is neglected to have all parts of the machinery always in effective condition—brakes, each and all, in perfect order, every man at his post, and a competent and vigilant superintendent over them to enforce discipline and command the train.

A supply of sand is not neglected; for, though the brakes completely control the train in ordinary weather, yet, when the cold is intense, and the track, wheels, and brakes are all covered with snow frozen into hard ice, they will not hold. Then, as usual, sand is applied in front of the forward drivers or in front of the middle drivers, as is, under the circumstances, most expedient; and the friction may be increased to whatever amount is necessary for the safety of the train.

With the passenger trains, there is a man at the brake on every platform, who never leaves his post while on the mountain, whether the train be ascending or descending. For the freight trains, four brakemen are required to attend to the brakes of three cars, or five brakemen to those of four cars.

Such tracks as this over the Blue Ridge are very dangerous under negligent or unskilful management. But with care to observe the rules prescribed, and to keep within the authorized loads and speed, they are quite as safe as, if they are not safer than ordinary railways worked with ordinary care.

CURRENT EXPENSES OF THIS TRACK.

The current expenses of maintaining and working this track are scarcely as great as might be expected from its anomalous and difficult character.

The ordinary consumption of fuel by one of the mountain engines, ascending the eastern slope of the mountain, from the foot of Robinson's Hollow to the summit—a

distance of $2\frac{6}{10}\frac{2}{0}$ miles—in which an elevation of 660 feet is overcome, and many curves of 300 feet radius are turned, is 42 cubic feet, or very nearly one-third of a cord. The total weight of the engine and train, or mass moved, is 70 tons.

The cost of fuel is there $2 00 a cord.

The fuel used in traversing the whole length of the track, from the Greenwood Station to the western base of the mountain, a distance of 8 miles, including both the ascent and descent of the mountain, is two-thirds of a cord, costing $1 33, exclusive of the cost of firing up.

The total cost of working the two engines when making two round trips each per diem, is as follows:—

2 Engineers, at	$75		each	per	month	.	.	$150 00
6 Brakemen, "	20		"	"		.	.	120 00
2 " "	25		"	"		.	.	50 00
2 Firemen, "	25		"	"		.	.	50 00
2 " "	17	50	"	"		.	.	35 00
1 Machinist, "	75		"	"		.	.	75 00
Wages of engine and train hands, per month						.	.	$480 00
Fuel, oil, &c., for two engines, per month, when making each four trips a day						.	.	350 00
								$830 00

Annual locomotive expenses, $9,960.

MAINTENANCE OF THE ROAD.

Salary of Superintendent, per annum . . .	$1,200 00
2 Section Masters, each $400	800 00
12 Laborers (negroes), at $150 per annum . .	1,800 00
1 Laborer at wood station	150 00
2 Watchmen at trestles, $240	480 00
1 Night Watch at terminus	365 00
Annual Cost of Superintendence and Maintenance .	4,795 00
Add Locomotive expenses	9,960 00
Cost of Maintaining and Working	$14,755 00

or, per mile per annum, $1,845.

To this total must be added, of course, the cost of repairing the locomotive engines and cars; and also the depreciation, properly due to this track, of the cars and engines and the track itself.

The engines, when delivered to the Company, were all exceedingly substantial, and have needed but small current repairs beyond what the machinist of the track has been able to give to them and to the cars. No separate account has been or could be kept of the other repairs of the cars—the track being worked in connection with the road east and west of the mountain.

Depreciation is always a very important item of railroad charges; but, while the machinery and track are comparatively new, any estimate of that item which might be here offered would be altogether speculative—while the object of this paper is to present only ascertained and reliable facts.

The writer does not wish to close this brief description of a road which, though built for a temporary purpose only, he thinks is likely to exercise a material influence on many future works, without duly acknowledging his obligation to those gentlemen whose co-operation materially aided in the rapid progress and great success of the work.

To his principal assistant, Thomas S. Isaac, he is indebted for the skilful and accurate execution of his plans:

To C. R. Mason and Wm. S. Carter, contractors, for their great energy and obliging promptitude in providing and applying their forces wherever needed to press forward the work:

To Messrs. M. W. Baldwin & Co., of Philadelphia, for the excellent engines that work the road: and, finally,

To George S. Netherland, superintendent of this track and machinery, for his prudence, carefulness and indefatigable and intelligent personal attention to the maintenance of the way and the management of the transportation across the mountain.

No. 288 H Street, Washington, D. C.,
Dec. 1, 1856.

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